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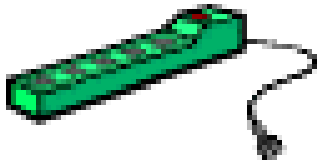

The Status of Interconnection for Distributed Generation in California

A Presentation to the CEC Siting Committee Workshop on Interconnection Rules

December 6, 1999

Millennium Minus 25

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Background - The History Effect

- Historically, utilities owned all generation, all transmission, all distribution
- Until recently, power plants were becoming larger and larger, farther and farther away
- In 1978, PURPA was enacted, mandating that utilities buy from QFs
- Under PURPA, many IPPs were selling power to utilities at prices far in excess of the costs for utilities to generate power themselves
- Today, utilities own very little generation and would like to own even less. IPPs, many of them affiliates of utility parents, will soon own most generation
- Rule 21, non-utility interconnection guidelines, was developed for QFs, or PURPA suppliers
- Most QF generation came from very large power plants

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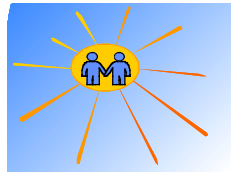
Foreground: The Voltage Effect

- Most transmission lines (500 kv to 66 kv) are networks , designed for two-way flow
- Most distribution feeders (22kv to 4kv, then to 650 V and 110/480V) are radial , designed for one-way flow
- High voltage failures knock out wide areas; low voltage failures knock out limited areas
- The quality of data, monitoring and controls is proportional to line voltage
- Each utility has no more than a few hundred high voltage circuits
- Each utility has several thousands of low voltage circuits
- In rare circumstances, low voltage failures can cascade into massive failures, and utility systems are designed to minimize the potential for this
- Upgrading all circuits to two-way flow capability will cost billions
- Most power plants today connect to high voltage lines



The Long-Range Effect: Distributed Generators Everywhere?

- DG is still a very small fraction of total generation
- Today, almost all DG g rid benefits are local; at low voltages, uncertainties are greater, and grid benefits are extremely hard to quantify
- With fuel cells, microturbines, Photovoltaics etc., life is changing
- Most emerging DG will use static power conversion, with integrated relays, controls, frequency controls, line sensors
- Utility rule 21 generally requires discrete relays, controls, etc., Often specifying the device to be used
- Everyone agrees that very small DG connected to a very robust system is okay. Such DG provides no grid benefits
- By contrast, DG connected to a weak line may provide grid benefits, but determining the benefits is very difficult, and uncertainty may overwhelm perceived value

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Current Effects: Things are Changing

- California, was the leader in distributed generation. CADER, started by the CEC and others, is the granddaddy DG group
- CADER helped initiate the OIR and thus this OII
- CADER realized years ago that lack of cost-effective interconnection is the most critical impediment to DG
- CADER s interconnection committee, INCOM, started work towards developing a consensus for simplified interconnection a year ago
- The consensus-building was supported by Utilities, manufacturers, IPPs
- Every California IOU has already started an effort to simplify its rule 21 specifically to assist with DG interconnection (examples follow)
- This OII will drive the process rapidly forward

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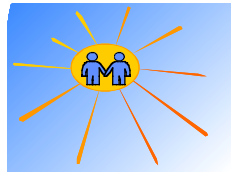
SCE Interconnection Status (Courtesy SCE)

- SCE has a Significant Amount of Third Party Generators Interconnected Today

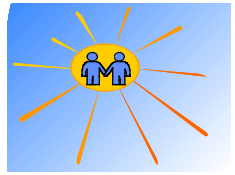
Technology Type	Less Than 200 kW	Greater Than 200 kW & Less Than 1 MW	Greater Than 1 MW	Total
Biomass	4	5	21	30
Cogeneration	108	18	55	181
Geothermal	0	0	20	20
Small Hydro	15	19	7	41
Solar	4	0	8	12
Wind	4	0	61	65
Total	135	42	172	349



Interconnection Concerns

(SCE Work-in-Progress)

- SCE Requires a Distributed Generator to be PURPA Qualified to Operate in Parallel with SCE Distribution System
  - SCE has requested CPUC approval for removing this requirement in conjunction with the filing of a new standby tariff for Non-QF DG units
- Standby Rates are a Barrier to Entry
  - Standby rates should reflect the full cost of providing standby service
- Utility Controls Timeline to Process Application
  - SCE s current practices allow for expeditious interconnection of DG less than 200 kW
  - SCE supports establishment of standardized agreements
- No Way to Verify Accuracy of Information Given by the Utility (e.g., design assumptions, study results, etc.)
  - SCE will improve communication of project information
- Ownership of Special Facilities Remains with the Utility
  - SCE requires ownership only where needed for system reliability and safety



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Potential SCE Interconnection Improvements

(SCE Work-in-Progress)

- Streamline Required Contracts / Agreements
- Develop SCE Single Point of Contact
  - Web Based Information Site
  - User Friendly Checklist
  - E-Mail Request Template
- Improve Billing Practices for Studies
- Improve Communication of Design Assumptions and Rationales

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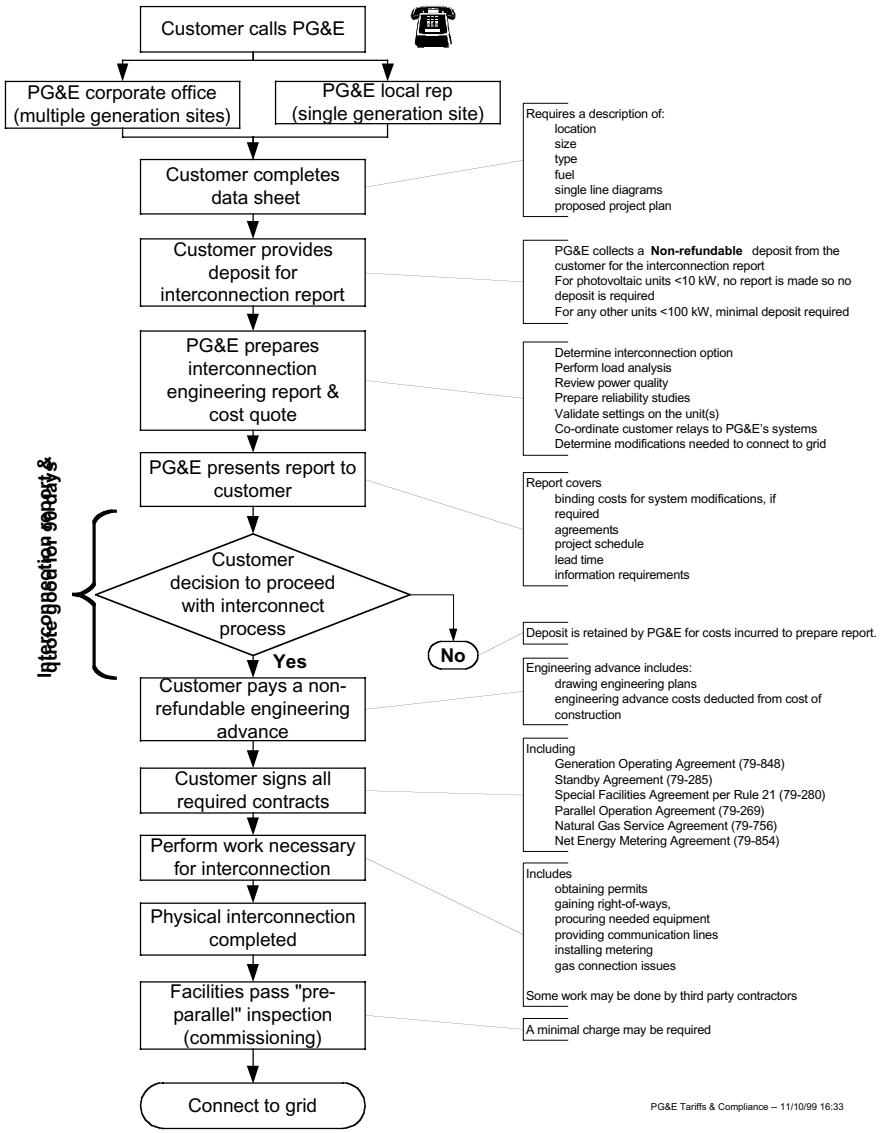
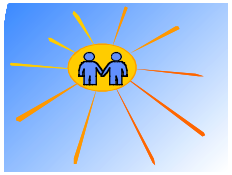
PG&E's Distributed Generation Interconnection Process



PG&E Tariffs & Compliance -- 11/10/99 16:33



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Sample of PG&E Work-in-Progress

Size of DG unit ***	**Energy flow**	**PG&E circuit**	**PG&E criteria for study ***	**Distribution system protective equipment Rearrangement or special facility costs [4]**
Aggregate generation., 1 kW - 300 kW Induction units	No flow into PG&E system	Distribution, Radial	Key factors: Number of units in project (aggregate size of DG for project); number of DG units on circuit; Location of units on circuit.	Case by case - determined from detailed interconnection study. **RPR [6] option for no flow back.**
Aggregate generation, 300kW - 1 MW Induction units	No flow into PG&E system	Distribution, Radial	Key factors: Number of units in project (aggregate size of DG for project); number of DG units on circuit; Location of units on circuit.	Case by case - determined from detailed interconnection study. **RPR [6] option for no flow back.**

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SDG&E View of DR Interconnection Needs

- Interconnection requirements are needed for protection of personnel and Public (SAFETY FIRST)
- Interconnections requirements are needed to maintain reliability for our system and customers
- DR facilities requesting parallel connection to the grid must meet protection guidelines of Rule 21
- Collaborating with technology suppliers to streamline interconnection requirements for DR technology using power inverters, (such as UL 1741)
- Utility participation in DR is imperative to maintain distribution system reliability and safety

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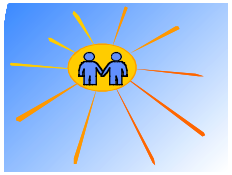
SDG&E DR Remaining Issues

- Control of DR systems are issues to be resolved through field demonstrations
- Interconnection agreements and stand-by rates need to be resolved without undue burden to customer base
- Full utility participation to facilitate distribution system support at key locations in the system including customer facilities



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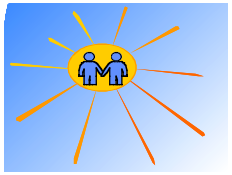
Rough Comparison of Current Thinking on Break-Points for Classes ofDGs							
PG&E	**0-10kW PV**	**10-100 kW PV**	**>100kW PV**	**1-300 kW Agg.**	**300kW - 1mW**	**1-20mW**	**>20mW**
SCE	**0-35kW**	**0-100kW**	**0-200kW**	**200kW-1mW**	**>1mW**		
SDG&E							
CADER/ INCOM	**<10kW**	**10-200kW**	**200kW-1MW**	**>1MW**			



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Draft Consensus Proposal to the ICBM, San Diego, Feb. 11, 1999

Requirement	<10kW	10-200kW	200kW-1MW	>1MW
Distribution Line Ground Fault Detection?	NO	Yes	Yes	Yes
Synchronization method****	Auto or manual	Auto or Manual	Auto reqd	Auto reqd
Dedicated Transformer Reqd?	No	Yes*	Yes*	Yes**
Utility Study Reqd?	No	Yes**	Yes**	Yes
Relay Setting Reqmts (ANSI 59,51 or 51V,27, 81, 32)****	Factory settings OK	Factory settings OK	Field Setting capability reqd., coordinate settings with utility.	Field Setting capability reqd., coordinate settings with utility.
Discrete Relays Needed?****	No, they may be part of the control system with fail-safe features.	No, they may be part of the control system with fail-safe features.	No, they may be part of the control system with fail-safe features.	EM or microprocessor with backup protection.
Periodic Relay function Testing Needed?****	No	No	Yes	Yes
Disconnect Reqd?	No	Yes	Yes	Yes
Power factor control reqd?***	Minimum 0.95 p.f. must be achieved	Minimum 0.95 p.f. must be achieved	Minimum 0.95 p.f. must be achieved	Minimum 0.95 p.f. must be achieved
Voltage control reqd?****	Voltage must follow line volts	Voltage must follow line volts	Voltage must follow line volts	Voltage must follow line volts
Metering Reqmts?****	Later	Later	Later	Later
Communication/Remote Control Reqmts?	Later	Later	Later	Later
Power Quality Std	Conform to IEEE 519-1992	Conform to IEEE 519-1992	Conform to IEEE 519-1992	Conform to IEEE 519-1992
DC Injection	DC current < 0.5% of rated, per P929	DC current < 0.5% of rated, per P929	DC current < 0.5% of rated, per P929	DC current < 0.5% of rated, per P929

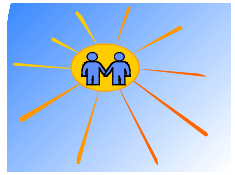
Note: These gudelines assume that the interconnectio voltage will be below 25 KV. It is not anticipated that any DG vendor will desier to interconnect at higher voltages

* The Dedicated transformer does not have to be new. An existing transformer connected to that customer is adequate. Multiple units from one party may connect to one transformer, but each party must have its own dedicated transformer.

** If generator output is less than transformer, simplified study. Otherwise, detailed review

***Line power factor compensation capability reqd for capacity certification

**** These may be solid state or electromechanical devices, but must be UL listed. See PG&E guide, pages G2-21 and -22 for explanation of device numbers.



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For Effective Change, We Should Understand That:

- The issues related to interconnection are complex and contain historical baggage
- Current rules are too cumbersome, but any changes should be carefully evaluated prior to implementation
- The utilities are no longer in an adversary role, but their interests should be recognized
- New technologies are changing the means and potential cost of interconnection
- Grid benefits are easier to talk about than to realize
- Change is already underway
- With goodwill, coordination, flexibility and compromise, simplified interconnection rules can be realized within a year